WAPA Wind/Transmission Study
AWS Truewind Scope of Work

1. Site Selection

The first step is to identify the locations of existing wind projects feeding into the transmission grid, along with planned projects, and to select likely sites for future wind projects within the seven broad areas identified in the RFP. The first stage of site selection will be based on publicly available wind resource maps of the Dakotas produced by NREL. The maps will be imported into a GIS and combined with other information such as the existing transmission grid, roads, and population centers. Parks, national forests, and other environmentally and culturally sensitive areas will be excluded from consideration.

New wind resource maps of each selected site will then be generated using AWS Truewind's MesoMap system. The maps will be produced for an appropriate turbine hub height, with a 200 m grid spacing, and will be thoroughly validated using available on-site and off-site wind data. The purpose of creating these maps is to select specific wind project sites at varying capacity levels (from 50 to 500 MW), and to provide a basis for accurately estimating the output of the projects as well as appropriate grid interconnection points.

2. Hourly Wind Generation Simulation

Next, for each potential site identifed in the previous step, and for each capacity level, we will create a year of historical hourly-average wind generation data. It should be stressed that the data will represent actual historical wind conditions for specific times in the past, rather than synthesized or averaged data. TrueWind's mesoscale weather model, MASS, will be run to recreate wind conditions across North and South Dakota and parts of the surrounding states for 365 days from a year specified by WAPA.

The MASS runs will provide a self-consistent set of 8760 historical wind speed and direction values at the turbine hub height for any point in the region where a wind plant might be developed. The data will faithfully reproduce correlations between project sites caused by regional and local weather patterns, and thus will accurately capture the benefits of geographic diversity in reducing aggregate wind plant output variability over the entire grid. For each site, the mean speed will be scaled to match estimates of the average speed derived from onsite data (where available) and from the wind resource maps. Using a generic power curve for a large, state-of-the-art wind turbine, including expected plant and wake losses, we will convert the wind speed values to a time series of wind plant generation for several assumed plant sizes ranging from 50 to 500 MW. A weighted moving-average filter will be applied to simulate the effect of aggregating the output of individual turbines within a plant.

AWS Truewind has used the same method successfully in a study of the integration of wind energy on the New York transmission grid, which was conducted for NYSERDA and NYISO. Figure 3 shows an example of the simulated hourly wind plant output for the Madison wind project in Madison County, New York, over a period of one week. Also shown is the actual plant output for the same period. Over a two-year period, the predicted and actual energy output of the project differed by less than 5%..

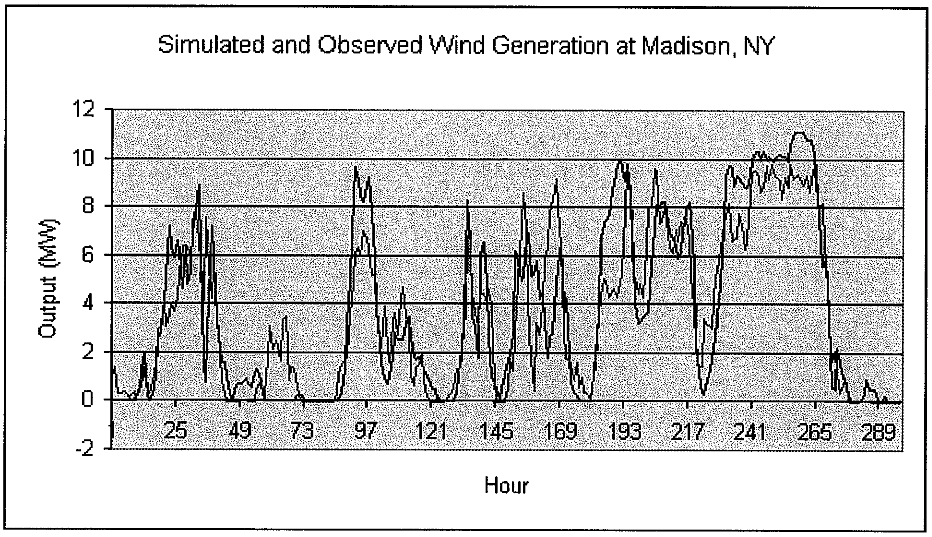

Figure 2. Example of simulated and actual generation for a two-week period at the 11.5 MW Madison wind project in Madison County, New York.

3. Validation

The next step will be to validate the wind speed and plant output data to ensure they are as accurate as possible, particularly in their diurnal and seasonal characteristics. This validation will be carried out using available wind resource and plant output data either from the sites or the surrounding areas. Through its extensive mapping and site assessment work in this region, AWS Truewind has access to a wide range of wind measurements. Possible data sources include NREL, state and regional wind resource monitoring programs (such as the UWRAP program), and private developers.

The expected accuracy of the mean wind speed estimates is about 5%. (A 5% error margin in wind speed translates into an error margin in mean wind plant output of 5-10%.) This is based on extensive validation of AWS Truewind maps in the United States carried out jointly by NREL and AWS Truewind using data from hundreds of monitoring stations. As an example, a scatter plot from the validation of AWS Truewind's New Mexico wind map is shown below. This plot compares prediced and measured long-term wind speeds at 50 m height. In this case the map standard error margin was found to be 0.24 m/s, or 3%, after accounting for uncertainty in the data. The mean error was about 0.1 m/s, or 1%.

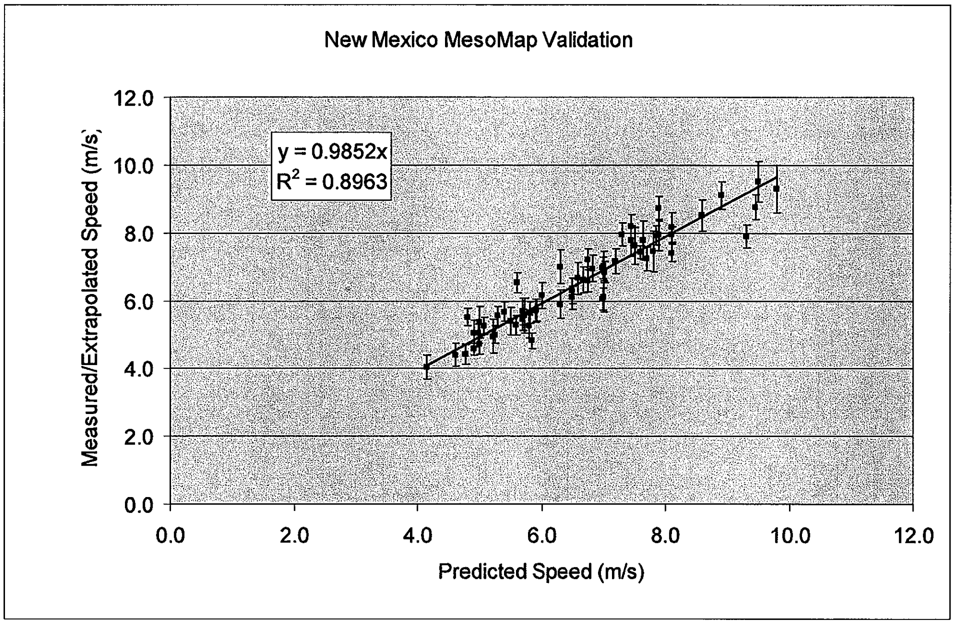

Figure 3. Example of MesoMap validation.

Care will also be taken to ensure that the hourly wind plant output displays the correct diurnal, seasonal, and dynamic (time-varying) patterns. As an example of the type of validation that will be performed, in our New York grid integration study, we compared the simulated and actual mean absolute change in plant output over different time spans at the Madison wind project. We found very good agreement, as shown in Figure 4. The mean absolute deviation, or MADEV, is the average absolute change in plant output over a specified number of hours. The curves labeled MADISON-TURBINE and MADISON-PLANT show the actual variability at individual turbines and for the plant as a whole over a two-year period. The SIM curves show the MADEV for the simulated generation data extracted for a single model grid point (SIM POINT), and filtered (using a weighted moving average) to represent the existing Madison project (SIM 11.5 MW PROJECT) and a possible 50 MW project located at the same site (SIM 50 MW PROJECT). Over few hours, the model grid point exhibits slightly more variability than a single turbine, whereas over just one or two hours, it exhibits slightly less variability. After the filtering, the simulated Madison project MADEV tracks the actual curve very closely. As the last curve shows, expanding the project to 50MW would result in only a slight additional reduction in the MADEV. This reflects the high degree of spatial correlation in wind speeds averaged over one hour on a wind project scale.

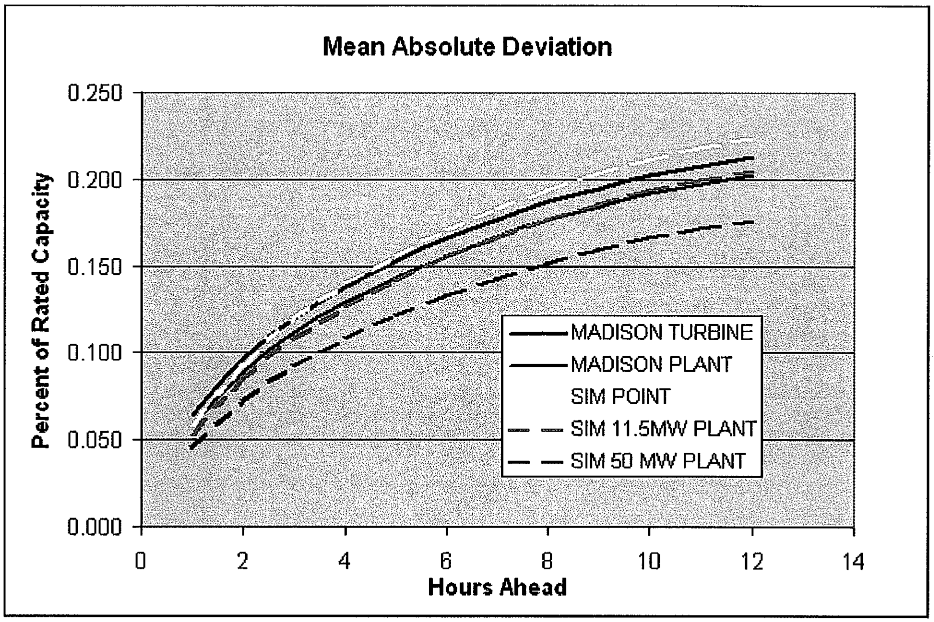

Figure 4. Mean absolute deviation (MADEV) of simulated and actual wind plant output at the Madison, New York, wind project.

The previous charts and discussion exemplify the thorough validation AWS Truewind will conduct in the proposed study using historical data acquired from various sources. A key source of wind plant data will be NREL's Wind Farm Monitoring Project, which includes the Lake Benton, Minnesota, and Storm Lake, Iowa, projects. Where signficant, systematic deviations between the model and data are detected, we will make appropriate adjustments to the simulated values. We will work closely in all phases with NREL in this process.